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By B.I. DYBERN

1969

Belgium

(E. Leloup and R. De Clerck)

Regular observations on salinity, oxygen, BOD, pH, ammonia and phosphate content and the bacterial status of the coastal waters have been carried out.

Research has been made concerning disposal of domestic and industrial waste water into the sea by a pipe-line and by ship.

Les activités de la Belgique comporteront une étude des conditions actuelles du milieu marin et benthique qui débutera au large de Nieuport, en 1970, et sera poursuivie en 1971.

Canada

(J.M. Anderson)

Anti-pollution programme

The Fisheries Research Board's four Atlantic Area Laboratories and the Resource Development Branch of the Department of Fisheries and Forestry were heavily involved in anti-pollution work in 1969 - much of it in co-operative programmes.

A costly incident occurred when a plant producing elemental phosphorous, by electric reduction of fluorapatite, accidentally discharged large amounts of suspended and colloidal phosphorous into Long Harbour off Placentia Bay, Newfoundland, in February 1969. Massive herring mortalities occurred. Poisoned fish turned red, probably because of hemolysis. It was firmly established that the phosphorous emanating from the effluent, and from bottom mud, was the sole cause of toxicity.

Low oxygen levels caused by pulpmill effluents, often combined with toxicity of these effluents, are creating concern over salmon migration in the St. Croix River, the Restigouche River, the Miramichi River and the Saint John River in New Brunswick, and the Exploits River in Newfoundland.

The pollution load along the length of the Saint John River, notably its upper reaches, is particularly great. Using computer techniques, a mathematical model has been formulated to predict the necessary level of improvement in water quality that will occur when waste treatment facilities are operational at the major sources of pollution.

In coastal pollution studies, at Long Harbour and elsewhere, work has been undertaken to determine the flushing characteristics of coastal inlets with a view to determining the physical capacity of such waters to accept pollutants.

Communities of attached diatoms are good indicators of severity of metal pollution (copper-zinc) from mining operations, or of acid pollution. Three degrees of metal pollution can be distinguished from flora along river banks. Copper and zinc are less toxic to salmon in both acid and alkaline waters. The cause of severe acid pollution below base metal mines was shown to be thiosulfate and polythionates.

Corexit 7664, an oil dispersant, is relatively nontoxic to fish (incipient LC50's approx. 500 mg/l for herring and salmon) but becomes markedly less effective in dispersing bunker C oil as temperature decreases. Unfortunately, XZIT, which has a negative temperature coefficient for its oil dispersing ability, is quite toxic to marine life.

Five polychlorinated byphenyls (PCB's) had lethal thresholds of about 1-3 mg/l for marine Gammarus, and one was slightly less toxic to salmon. The insecticide DDF had a seven-day LC50 of 0.12 mg/l per salmon; the organophosphates Dylox and Bay 77488 have four-day LC50's of about 3 and 1 mg/l respectively. After aerial forest spraying (approximately 2.8 million acres) with Sumithion (an organophosphate insecticide), salmon and trout showed no significant decrease in acetylcholinesterase activity, although white suckers did.

Further work has led to a modification of the effect of sublethal DDT on the learning behaviour or fish. By manipulation of certain experimental conditions, salmonids treated with DDT will learn a conditioned avoidance response. There seems little doubt, however, that DDT can alter a fish's natural repertoire of unconditioned responses in a given conditioning procedure. These alterations may render the fish essentially incapable of performing the task chosen as a criterion of learning. The work is being extended to include chlorinated hydro-carbons other than DDT and organophosphate biocides.

Transplantation and special fish rearing programmes

The Mactaquac Salmon Smolt Station, in its second year of operation in 1969, made its first smolt release of 100 000 during May and June. This release comprised 80 000 age II smolts, brought to the Station as yearlings for completion of their final year of rearing; and 20 000 of age I, progeny of the first brood stock collection made in 1967.

Assessment of the salmon rehabilitation of East River, N.S. was continued. A run of 4 000 smolts, progeny of the first adult transplants in 1966, was numerated on their downstream migration from the major tributary stream of the system. Migration delay in the upper power dam forebay was overcome by adapting a simple "skimmer" device to collect smolt at the surface. Testing of the louver deflectors at the lower canal was continued and results indicate that further modifications are needed to provide a greater bypass velocity in order to improve the guiding efficiency of the louver installation. In the first phase of the La Have River development programme, construction of a concrete vertical-slot fishway to provide access over a 21-foot high natural rock falls was completed in 1969.

Several transplants of pink salmon, Oncorhynchus gorbuscha, eggs were made to a small river in southern Newfoundland during the period from 1959-1966, the largest being 5.9 million eggs in 1966. The greatest adult return (spawning escapement plus known commercial catch) has been 8 440 fish in 1967 from a transplant of 3.3 million eggs in 1965. The first return from natural spawning only occurred in 1969 (2 603 fish from a spawning escapement in 1967 of 5 334).

In oyster work, studies continued on alternatives to hatchery production of oyster seed with a view to developing more economical means of off-bottom culture. In addition, work was done on planting of scallop shells to increase the amount of bottom habitat suitable for spat settlement. Hatchery facilities (at the Ellerslie Sub-Station on Prince Edward Island) were improved for rearing of animals under quarantine conditions with a view to producing disease and parasite-free spat and young stock.

Denmark

(O. Bagge)

In connection with problems in industrial pollution the toxicity to fish of certain compounds has been studied. In 1969 especially the toxicity of the flourides NaF and Na_2SiF_6 have been considered. Comparisons between action in fresh and salt water were made.

Investigations on the contents of heavy metals (Cu, Hg, Pb, Ag and Zn) in bottom sediments and in mussels (Mytilus edulis) have been carried out in the Little Belt and the Limfjord.

Finland

(A. Voipio)

Some coastal areas are investigated as to their pollution conditions, especially outside Helsinki, where a pipe-line carrying out waste waters from the city will be constructed.

The co-operation between Finland and the U.S.S.R. in the Bay of Finland has been continued.

France

Germany

(A. Kotthaus)

Fish rearing and culturing

Rearing experiments with sole, turbot and other North Sea fish were continued at the previous lines at the 'Biologische Anstalt Helgoland'.

Large scale feeding experiments with the rainbow trout in netcages were started by the 'Institut für Küsten- und Binnenfischerei', Hamburg, in the western Baltic. Several kinds of food were tested. The first results of these experiments are encouraging; the fish showed a fast growth.

Water pollution

The pollution of coastal waters is the central problem of the German investigations. German experts (Prof.,Dr. Mann and Dr. Weichart) were actively co-operating in preparing the ICES report on "Pollution of the Baltic".

Three years ago the 'Deutsche Forschungsgemeinschaft' had initiated a central programme on "Littoral research and pollution of coastal waters", in which now all German institutes concerned with marine research, including those of the universities at Hamburg and Kiel, are engaged.

The research was mainly concentrated on the problems of pesticides. Investigations were started to get information on the toxicity of these for different marine organisms, as well as on their accumulation in fish and other marine animals. Investigations were also started on the toxicity of organic mercury compounds to marine organisms and the accumulation of such substances in them.

Other investigations were made on the influence of industrial wastes on plankton and benthos animals in those areas in which such wastes are liberated (f.i. sulfuric acid and ferrous combinations of a titan plant). Besides investigation in the laboratory, corresponding ones were carried out in the open sea, especially with respect to the influence of these wastes on the development of floating eggs.

Finally investigations in connection with pollution must be mentioned including the search for and the examination of emulsifying agents. Moreover, the influence of oil on variations in the occurrence of bacteria, yeast and other fungi was studied.

Iceland

(Jón Jónsson)

Nothing to report for 1969.

Ireland

(F.A. Gibson)

The research work into organochlorine pesticide residues, being carried out by Mr. J.P. Timpson, was continued during 1969. Two river systems were surveyed in detail, and water, mud, insects and trout, sampled

from numerous sites on these rivers, were analysed for their pesticide content. A fairly clear picture of the individual relative contributions of agriculture, industry and urban populations, to fresh-water environmental levels of pesticides, is already emerging.

Organochlorine levels in various tissues of salmon at different stages of their life cycle, have been determined in an attempt to pin-point where and when the fish accumulate most of their pesticides. Salmon from a clean river, with respect to pesticides, and from a river receiving organochlorine effluent, were analysed.

Laboratory work is in progress on the toxicity of pesticides to rainbow trout being maintained under differing conditions. This section of the project is designed to examine the metabolism of pesticides within fish and will, it is hoped, clarify the position with respect to uptake and fate of pesticides in salmon, in the wild.

Investigations were made into the toxicities of crude oil and two separate detergents, on Mytilus edulis and Littorina littorea, under artificial tidal conditions. The detergents used were Corexit 7664 and Dispersol OS.

Netherlands

(P. Korringa)

In the summer of the year 1969 the Netherlands mussel industry came temporarily in great difficulties when the main cleansing plots in the vicinity of Yerseke suddenly showed signs of serious faecal pollution. Therefore the season had to be closed prematurely. Investigations demonstrated that the cause of the pollution was the sewage produced by the city of Goes, which sewage is disposed off in a canal leading to the Oosterschelde. Selfpurification normally occurs in this rather long canal, but increase in the production of domestic waste led to pouring of contaminated water into the Oosterschelde some ten kilometres west of Yerseke. Tidal currents carried out this contaminated water to the cleansing plots near Yerseke. The measure taken was chlorination of the water on its way from Goes to the Oosterschelde. This measure proved to be successful and brought the coli-counts back to their normal level. After re-opening of the season sanitary conditions were normal for oysters and mussels.

A plankton survey was carried out in the Dutch coastal waters at regular intervals in an effort to trace possible outbreaks of dinoflagellate populations. Such outbreaks did not occur in 1969. Mussel samples were examined for the presence of paralitic shellfish poison by the mouse-test. No positive data were encountered.

Norway

(E. Føyn)

The cultivation of blue mussels is studied by 'Fiskeridirektoratets Havforskningsinstitutt", Bergen in co-operation with 'Statens Biologiske Stasjon' in Flødevigen.

Commercial fish farming takes place in different plants at various localities in Norway and studies are performed in order to improve the methods and the yield of these plants.

Pollution of the sea and the effect of pollutants on marine organisms cause increasing problems in Norway as in many other countries. Different studies of the pollution from domestic, agricultural and industrial waste of fjords and near-shore waters are continued at the institutes of marine biology in Oslo, Bergen and Trondheim, as well as at 'Norsk Institutt for Vannforskning (NIVA)', Oslo and 'Fiskeridirektoratets Havforskningsinstitutt', Bergen.

In connection with these investigations the quantity of heavy metals, pesticides and radioactive compounds in fish and fishproducts has also been controlled. The results show as a whole values far below the maximum permissible levels, but the content of mercury has in some special cases been found to be too high. In co-operation with Mrs. M. Swedmark, 'Kristinebergs Zoologiska Station', Fiskbäckskil, Sweden, studies of the effect of tensides on marine organisms are carried out at the 'Institutt for marin biologi' in Oslo.

The variation of pH in Norwegian freshwater is studied and investigations of the effect such variations may have on the population of salmon and trout in Norwegian waters are in progress at 'Direktoratet for Ferskvannsfisket', Vollebekk.

Poland

Portugal

(H. Vilela)

No special research has been done during 1969.

Spain

(O. Cendrero)

Studies will be carried out in the Mediterranean in order to improve the yields of the fisheries. These studies will include experimental fishing with longlines, lobster traps and trawls, fishing with artificial light and search of Cephalopods with special gears that may be unlikely to catch or seriously damage other species.

Sweden

(B.I. Dybern)

Baltic Sea

The research on Baltic pollution conditions has increased and now involves physical, chemical, geological, meteorological, biological and toxicological parameters. Most oceanographical and part of the biological research work is carried out within the international co-operative organisation "The Baltic Oceanographers". Efforts are made (not only from Sweden) to start an international collaboration as to Baltic pollution research and abatement. Within Sweden efforts are made to centralise at least the most important projects.

West coast

Co-operation with Norway has started concerning the pollution problems of the Idefjorden-Koster area on the border-line between the two countries. The Danish-Swedish collaboration in the Øresund has continued.

Two reports on the influence of industrial waste waters (from oil-refineries and related industries) in the Stenungsund area and sewage water (including some industrial waste water) from the city of Göteborg demonstrated a certain damage to fishery.

Toxic substances

The investigations on marine and fresh water fishes and other organisms as to their contents of heavy metals, chlorinated hydrocarbons etc. have been considerably extended and now cover most parts of the country and the sea area outside. Some new areas have been black-listed. Investigations have also been started to estimate the amount of toxic substances carried out into the sea through the main rivers.

United Kingdom

1. England and Wales

(H.A. Cole)

Fish cultivation

At the Marine Hatchery, Port Erin, Isle of Man we have developed empirical rearing techniques for plaice (Pleuronectes platessa L.) and sole (Solea solea L.) which have been adapted to mass-production purposes. Our

current programme seeks to improve existing hatchery production methods for these and other valuable species such as the lemon sole (Microstomus kitt Walbaum), and the turbot (Scophthalmus maximus L.). The halibut (Hippoglossus hippoglossus L.) and the haddock (Melanogrammus aeglefinus L.) are also of interest.

Special attention is being paid to cultivation techniques for live larval fish foods (rotifers, molluscan larvae, copepods, enchytraeid worms) as alternatives to Artemia nauplii, and to the development of artificial diets. Research is in progress on the survival and growth of hatchery-reared flatfish larvae as a function of physiochemical and biotic variables like temperature, light, free chlorine and population density; also the pathology of marine food fish at all stages of morphological development. Some preliminary work will be done this year on methods for controlling the reproductory activity of captive spawners.

At the Fisheries Laboratory, Lowestoft, work has continued on genetic aspects of fish cultivation, on the analysis of growth mechanisms, on the optimisation of rearing techniques for sole and on hybridization. A particular effort will be made to perfect rearing methods for turbot and brill and to develop alternative supplies of live food for fish larvae to supplement or replace Artemia.

Shellfish rearing

Oysters. The development of large scale hatchery rearing of O. edulis at Conway continues to be slowed up by trouble due to a bacterial disease which attacks the larvae in early summer and by poor survival of the spat. The bacteria has been found to be a Pseudomonas type III. Work on food for the larvae has shown that the diatom Cyclotella nana is as good as Isochrysis and Tetraselmis and is relatively easily maintained in culture.

The adverse effect on the growth of oyster larvae of Phaeocystis in the supply water has been investigated.

Clams. Experiments have largely centred on the growth and survival of hatchery reared seed clams planted out in various estuaries. The young clams are protected against predation by plastic netting laid on the ground over the clams.

Prawns. Investigations have continued on the feeding and growth of Palaemon serratus and special attention has been given to the development of storable prepared food compounds.

Experiments with Pandalus platyceros gave maximum growth of larvae and post larvae at 18°C and 30‰ salinity. Growth and survival rates achieved were considerably greater than those for Palaemon serratus.

Experiments on the rearing of Macrobrachium rosenbergi have been encouraging and some individuals have reached 40-60 gm weight in 9 months on a diet of fresh Mytilus tissue.

Marine pollution

Toxicity investigations. Some 94 tests of the toxicity of oil dispersants, pesticides, polychlorinated biphenyls, herbicides and a few industrial effluents have been made using Crangon crangon, Cardium edule, oyster larvae, Agonus cataphractus and several flagellates as test organisms.

All tests to date have been of 48 hours duration, using static aerated water. An improved method, using a continuous flow of water, is being developed.

Experiments to determine the minimum concentrations of toxins which cause significant avoidance reactions among shrimps have shown that some toxins, such as copper, zinc, oil dispersants using aromatic solvents, phenol, sulphuric acid and some detergents are avoided at concentrations below the 48 hour LC_{50} value, while others, including mercury, DDT and azinphosmethyl, are not avoided at concentrations which will kill them in 48 hours.

Monitoring. The routine analyses of fish and shellfish for organochlorine pesticides from a number of areas round Britain have continued, and as in previous years, the highest concentrations (up to 2 ppm) have been found in the livers of cod and whiting. The levels in fish muscle were below 0.1 ppm

with the exception of herring which reached 1 ppm. During the year regular analysis for polychlorinated biphenyls was included, and gave values comparable to the pesticides.

Fortnightly samples of oysters and shrimps from the River Crouch have been analysed for pesticides to determine seasonal changes, which have been found to be greater for oysters than for shrimps (Crangon crangon and Pandalus montagui).

Experiments on the extent to which sunken oil fouled fishing gear showed that the results varied greatly with the type of oil and the sinking agent.

Studies have been started into the effects of pollution by paper mill waste and sewage in the Swale, Kent, and of dumping fly ash, colliery waste and dredging spoil off the north-east coast of England, and of dumping sewage sludge in the Liverpool Bay area of the Irish Sea.

Bacterial pollution of shellfish. Work on the methods of examining shellfish for E. coli have shown that the use of mechanical macerators is satisfactory and gives consistent results just double those obtained by hand maceration. Tests for E. coli, Streptococcus faecalis and Clostridium welchii as indicators of pollution have shown no advantages in the use of the latter two over the current standard tests using E. coli. Extensive studies have been made of the total aerobic bacterial content of non-polluted estuarine water and oysters living in it. Under warm weather conditions counts reached 10^7 per ml of flesh. The development of methods for cleansing clams (Mercenaria mercenaria and Venerupis decussata) has continued.

Dispersion of pollutants. At the Fisheries Laboratory, Lowestoft practical and theoretical studies of dispersion have been made and mathematical models are being developed from which it is hoped it will be possible to predict the spread of pollutants from points of discharge.

2. Scotland

(J. H. Fraser)

Several sections of the Aberdeen Laboratory have been collaborating in a study of food chains leading to fish in two types of echosystem in a west coast sea loch (Loch Ewe) - in a shallow coastal sand environment and in a deeper muddy environment. This has involved regular monitoring of the populations to assess growth and mortality rates as well as experimental field and laboratory work on behaviour and physiology.

On the sand, the respiration rate of the microbe populations was studied in winter and summer at various temperatures, and endogenous respiration was determined in sand column experiments. Fish sampling by longline showed the presence of significant populations of cod and haddock at night in depths as shallow as 1 fathom, and these may be important predators of juvenile flatfish. Experimental work on these plaice predators has continued, and a study was begun of the metabolic cost to plaice of gill ventilation under various conditions.

On the mud, an underwater station was established and regular measurements made of selected physical and chemical factors. In particular, equipment was set up to collect material sinking to the bottom which would contribute to the food chain, and an apparatus was designed to measure small bottom currents. The meio- and macrofauna of the mud is also being sampled and assessments made of the larger organisms which include Nephrops norvegicus and several round fish species.

The examination of the White Fish Authority pond at Ardtoe, reported in previous years, was continued in 1969 to detect the changes taking place as a result of submersion.

In 1970 it is planned to complete the main observations on the sandy ground by work on some aspects not already fully dealt with, in particular the relationship of the larger epifauna to the general food chain. On the muddy ground, intensive efforts will be made to determine the few species of macrofauna which make up the bulk of the biomass and which are too widely dispersed to be sampled by grab.

Mussel cultivation

Dr. Mason has continued his work on the experimental cultivation of mussels on ropes in Linne Mhuirich, an inlet on the west coast of Scotland. Growth and flesh condition have again been good during the past year. The year's observations have confirmed that harvesting should take place in the autumn when the mussels are 14-18 months old.

Commercial cultivation has now started. Mussels are a major item in the food of eider ducks in this area, but eiders are unlikely to be a serious nuisance unless their numbers increase as the mussel industry expands.

Plankton samples are taken monthly (Mr. Seaton) to assess the possibility of blooms of toxic organisms.

Pollution

It is intended that selected parts of the food chain in the sandy environment of Loch Ewe - on which we now have accumulated a considerable amount of information - will be used for a study of the long-term effects of various pollutants, probably including heavy metals and perhaps pesticides.

The study of the effect of the pulp mill effluent into Lochs Linne and Eil was continued in 1969.

Chemical, hydrographic and plankton surveys were made of the Tay Estuary to determine existing levels of pollution and as a base for comparison with further pollution induced changes. As part of this work on the Scottish estuaries, an internal mimeo report was prepared (Craig,R.E. and Adams, J.A.) on the plankton and hydrography of the Inverness and Beauly Firths. Laboratory studies were made on the rate of decay of crude oil residues on beach sand.

In relation to new industries being planned, experimental work has begun on the effects of phenols on marine plants and animals and on marine food chains.

A list of workers in the field of pollution at other institutes in Scotland, with brief notes on the subjects of their research was submitted to the Chairman of this Committee in May 1969.

The above programmes are being continued in 1970.

Pesticides in the marine environment (A.V. Holden, Pitlochry)

Analyses have been made of a large number of samples of blubber from several species of seals, taken around the coasts of England and Scotland, northern Norway, the Gulf of Bothnia, the Gulf of St. Lawrence and the Canadian Arctic. These samples indicate the relative degree of pollution of the various sea areas caused by organochlorine pesticides and polychlorinated biphenyls (PCB's). The Gulf of St. Lawrence, the Gulf of Bothnia and the east coasts of Scotland and England showed the presence of high levels of the DDT group of residues, and particularly high PCB levels were found in samples from the east coast of England. Samples of seal pups found dead on the south-west coast of England, and of pups killed on the north-east coast of England, also contained high PCB levels, and the sources of discharge of these chemicals, widely used in some industries, are under investigation.

Samples of five species of fish (herring, mackerel, plaice, cod and whiting) are now being taken twice yearly from six areas around the Scottish coast for organochlorine analysis. The Firth of Clyde has proved to be the area most contaminated by PCB residues, and following a serious mortality of sea-birds in this area in the autumn of 1969 further samples of fish, shellfish and plankton were taken. These confirmed the presence of PCB residues, which had been further accumulated by the birds feeding on the fish. The implication of PCB's as the direct cause of the bird mortality has not been established.

Other marine samples analysed included mussels and dogfish, which formed part of an OECD study of pesticides in the environment. This study, in which eleven countries participated, produced evidence suggesting that fish from the marine environment may contain higher residue levels than many fresh-water species.

Programme for 1970

Twice-yearly sampling of five species of marine fish from six Scottish sea areas, for pesticide analysis, will continue. The major sources of PCB contamination in Scottish waters will be investigated.

Further samples of seal blubber will be analysed, using a new technique to separate the pesticides from the PCB residues. It is hoped to obtain samples of killer whales, and of species of seals which are the subjects of other investigations.

Mussels and sprats will be analysed as part of a further OECD study programme, and it is hoped to examine samples of salmon from Greenland and Scottish waters.

U.S.S.R.

(S.G. Fedorov)

In 1969 the studies of acclimatisation of pink salmon in the basin of the White and Barent Seas were continued. About 8 millions fry were released into the rivers Umba and Onega from hatcheries of the Murmansk and Arkhangelsk regions. The spring of 1969 was cold and the young migrating into the sea were relatively small (about 6 g).

Of the 5 millions fry from hatcheries released in 1968 and of the fry from natural populations, 200 adult specimens of pink salmon were registered in catches taken in the waters of the Murmansk and Arkhangelsk regions. Thus the return yield was very low and estimated to about 0.01%.

Investigations on the reproductional conditions of the species were carried out from land and at sea expeditions. In 1969 the summer was cold and the autumn late (2-3 weeks later than normal). The conditions for spawning in pink salmon was, however, nearly normal during autumn.

At the end of June 800 specimens of the Kamtchatka crab (young and mature individuals) were released in the Kildin Strait area. Underwater observations showed that the crabs moved away from the shore to greater depths immediately after the release.

In 1970 the following problems will be considered:-

1) Downstream migration of the young of pink salmon in the rivers of Onega and Umba.

2) Abundance and migration conditions of pink salmon in the rivers of the Murmansk region.

In addition research will be continued on the effect of salinity and manganese ions on survival and metabolism of the Baltic flounder, different shellfish and crustaceans.